SCIENCE

FRIDAY, FEBRUARY 24, 1888.

WE CALLED ATTENTION a few weeks ago to the beginnings of a zoölogical garden at Washington. It now appears that plans for a similar undertaking have been in progress for some time in Boston, and are now made public in a correspondence between the park commissioners of that city and the Society of Natural History. Although only preliminary steps have yet been taken, the outcome appears to be that the park commissioners have agreed to place in reserve, and lease the society on a nominal rental for a long term of years, several pieces of land under their control, to be developed, under the auspices of the society, as natural-history gardens and aquaria, if the friends of the society will raise a fund of two hundred thousand dollars as a foundation for the enterprise. The society proposes to interest the general public in the matter by creating a new body of members, to be called 'garden members,' paying a certain annual sum for the support of the enterprise, and in return presumably receiving certain entrance privileges. In their reply to the proposal made by the Natural History Society, the park commissioners call attention to the peculiar situation of Boston, in that its territory is greatly divided by bodies of water and marsh, and its dry land by rocky ridges, causing the city to extend itself in a very irregular manner. This prevents the possibility of finding any one piece of land large enough for the proposed natural-history park, and leads the commissioners to suggest to the society the advisability of occupying several distinct pieces of land; so that the plan as developed includes a diversified but unwatered portion of Franklin Park, next the future pleasuring-ground of Boston, a section of the park below Jamaica Pond, and a salt-water basin, perhaps a quarter of a mile long, at City Point, South Boston. Such a division has never before, we believe, been attempted in a zoölogical garden, but, though obviously requiring a larger staff to operate it, has some advantages which should not be overlooked. It is thus possible to obtain for aquatic animals places specially suited to them, and to select ground of a very varied character for other parts of the garden without feeling dependent upon a great water-supply; while the establishment of the large marine aquaria at the very edge of the harbor has obvious advantages. Moreover, it brings all the citizens into near proximity to some part of the ground occupied. Another distinct feature in the plan is a most commendable one, though its advantages are not so apparent on financial as on educational grounds. The committee points out that the society has long developed its museum with the distinct purpose of making it auxiliary to the general scheme of education in the State, and within a recent time has given special attention to exhibiting the animals, plants, and minerals of New England, believing that its position as the leading natural-history society of this group of States imposes such a duty upon it. This same idea it would carry out in the proposed garden by making it in an especial way a reproduction of the true indigenous fauna of New England. For it is to be borne in mind, say the memorialists, "that with the increase of population, and the concomitant decrease of the indigenous wild animals; above all, with the modern excessive growth of city life, — the percentage of city children (and hence of all) who may ever hope to see, and still less to observe at their leisure, the living objects of their native State or country, is rapidly growing less. At the same time the importance of such observation and study, instead of decreasing in like proportion, is greatly enhanced. To the country boy it is of comparatively little moment whether he observes this bird or plant, or that, since he has usually definite ideas of all, drawn from frequent observation of many. But to the city lad it is of the utmost consequence that he shall be able to correct his less definite ideas — formed for the most part by hearsay, by books, or by pictures — by observation of the object itself." The enterprise now plainly depends on the public spirit of the citizens of Boston. It is the natural and proper outcome of the admirable park system of that city. The Natural History Society has had the plan in view for twenty years, and believes the time is now ripe for developing it. Surely no such scheme has ever been proposed in this country under more favorable circumstances, or with the promise of so powerful and substantial support. That the park commissioners perceive this, is evident from the readiness of their response to the application of the society's committee, and we shall look with confidence to a generous response from a city that has already done so much for science and education.

THE MOST IMPORTANT QUESTION discussed by the Department of Superintendence of the National Educational Association at its meeting at Washington last week was, 'How and to what extent can manual training be ingrafted in the public-school system?' It occupied the entire morning of the first day's session; and after the reading, by Mr. Charles H. Ham of Chicago, of a very thoughtful and eloquent paper, the discussion was taken up by a number of gentlemen, some of them the most prominent and influential educators of the country. Of all who participated in the discussion, only one, Mr. Marble of Worcester, — a gentleman whose idiosyncrasies on this subject we have lately criticised (*Science*, No. 257), — opposed manual training, he even going entirely beyond the limits of the question at issue in order to ventilate his views. The reports of the meeting which reach us go to prove that our previous judgment, that Mr. Marble knows nothing about manual training or the argument for it, was correct. We regret to understand, however, that at Washington he surpassed his previous efforts, and considerably exceeded the bounds of courtesy in his treatment of those who favor manual training. The consciousness that one stands alone in the wrong of so great a question as this, must be irritating, but it can hardly be offered as an excuse for the conduct in question. Argument by invective is becoming far too common in this country, and it is our duty to protest most emphatically against its introduction into educational discussions. The advance of a great educational movement is not to be checked by abusing either it or those who regard it with favor, and it was this abuse, without a line of argument, which made up Mr. Marble's fifty-minute harangue. President Butler, Dr. Belfield, and Mr. Newell very easily and briefly showed how entirely aside from the question it all was. The result of the discussion was the appointment of a committee of seven to draw up a course of study in manual training, and to report at the next meeting.

THE MISSISSIPPI PROBLEM.

THE improvement of the Mississippi River, on a large scale and systematic plan, enjoyed, from its inception to the last session of the Forty-eighth Congress, a most enthusiastic support. From the outset, the theories proposed as the basis of the work undertaken have been criticised and contested, but for a considerable time no opposition was directed to the constructions actually undertaken.

Happily all who had addressed themselves to the problem had been, so far as concerns the works in the bed of the river, substantially in accord as to the projects for the immediate application of the appropriations, while differing somewhat as to the reasons for

the work recommended, and still more as to the results to be expected of them. In such a state of affairs, the work could properly be continued; since the concurrent opinion of all as to the work to be done would probably be right, though of the discordant reasons and diverse expectations of individuals, some, of course, must be wrong.

At the beginning of the session above referred to, a strong and determined opposition developed to one of the principal features of the work proposed. It was stated that the revetment of caving banks was unnecessary and wasteful, since the object of that work, the cessation of caving, would result from the contraction-works, or those designed to concentrate the water over the shoals.

Some of the most active champions of the improvement and of the commission by which it was being carried on, announced the discovery that this commission had effected an insidious and dangerous change in its original plan, by virtue of which the objectionable feature of bank-revetment had been introduced or made more prominent. It is without the present line of argument to contest this statement, several refutations of which have appeared in print. The issue is now squarely made between revetment and anti-revetment theories, and must be met on its merits. It makes no difference, in the decision of the question, whether the Mississippi River Commission have changed front on it or not; except, perhaps, that if they have done so, it has been in the light of four years' experience, which in itself would be a strong argument in favor of their later views.

The two theories are so antagonistic that compromise is scarcely possible. The revetment or protection theory makes prevention of caving by means of this class of work one of the prime causes of the improved condition of the river: the anti-revetment theory predicts the cessation of caving as a result of the contraction-works. The one would stop the deterioration of the channel, and cut off one of the principal causes of impaired navigation, preliminary to or concurrent with the effort to improve the channel: the other would attempt to remove the effect, while leaving the cause in full operation.

The hypothesis on which the anti-revetment theory is based is very simple. It is assumed that the ability of flowing water to carry suspended sediment is directly proportional to its velocity; that at any given velocity it can carry a certain normal quantity, refuses more, and is not content with less; that if undercharged it takes up the deficit from the adjacent bed, producing scour and caving; if overcharged it drops the surplus on the spot, causing a fill. A corollary of this is, that if the channel can be so regulated that the velocity will be uniform throughout its whole extent, and always bear the proper ratio to the supply of sediment, there will be no scour or fill in the bed or on the banks of the stream; the sediment supplied by tributaries will be carried without loss or gain to the sea; the deterioration of the channel will cease; the bars, having been removed, cannot re-form; and the problem is solved.

As evidenced by their practice, engineers are overwhelmingly in favor of ideas the reverse of these. Many civil engineers have addressed themselves to the problem in the interest of individuals or corporations. No case is known where any of them have proposed any remedy for a caving bank, except a direct protection of some kind. When called upon to induce a scour along a bank, as in some cases of important landings, they have, strangely enough, successfully employed for that purpose the very means now proposed to prevent the same thing.

Such proponderance of professional opinion would be accepted in any question of law or medicine. In matters of engineering, however, the public demand not only that we shall be agreed, but that they shall be convinced. It is therefore necessary to further argue the question, and for the same reason the argument must be addressed, not to the profession alone, but to the public as well.

It is not proposed to test the hypothesis by any of the well-ascertained facts of the river's regimen. Thus no argument will be founded on the facts that by hypothesis the proportion of sediment should increase from the bottom to the surface, as does the velocity, whereas the increase is from surface to bottom; that the sediment should be greatest at the thread of swiftest water, and diminish toward either bank, as does the velocity, while, on the contrary, it is sensibly equal all the way across, and as often in excess on the slow as on the swift side; that a greater proportion of sediment should always be carried at a higher than at a lower stage, the reverse having been again and again observed; or that the rate of caving should be least when that proportion is greatest, which rarely or never happens. Nor will any attempt be made to weaken the force of this doctrine by pointing out any of the well-established causes of caving, such as outflow of ground-water, eddies, or whirls, and wash of wind or steamboat waves, which, being independent of the velocity, will survive any regulation of it which may be effected.

Inquiry will be made as to the applicability of this theory to the problem in consideration, or, in other words, whether the conditions under which the hypothesis is claimed to be effective can be produced in the Mississippi River. Should it be found that these conditions can be produced, the truth or falsity of the hypothesis could be quickly decided by trial. On the other hand, should it appear that the conditions precedent cannot be realized, the truth or falsity of the theory is immaterial.

The actual velocities or rates of current are, in the river's present state, any thing but uniform. Their distribution may be illustrated by the motion of the wheels of a cart driven over a crooked road. On a straight stretch, the wheels revolve with equal velocity. If a turn to the left be made, the right wheel is accelerated and the left retarded, and the reverse in case of a turn to the other side. If the curve be sufficiently short, the inside wheel stops; while, if still more abrupt, it must turn backward. Add to this that the top of each wheel moves faster than the bottom, and the motion of the water of the Mississippi and like streams is completely illustrated.

The channel of the Mississippi River is just such a road, and the relative velocity of its current at any point of its course may be readily predicated from the above analogy. The depth is always roughly proportional to the velocity. The highest velocity and greatest depths coincide on the concave sides of the bends, corresponding to the outside wheel on a curve, and it is here that the caving banks are found. On the convex side, deposits of sediment from the retarded currents are constantly being made, the accretions nearly, though not quite, keeping pace with the recession of the caving line opposite.

A word now as to the location and operation of the contraction-works, which are the means to be employed to bring about the required conditions. At every flood the river builds up its principal shoals, so that the bottom is as high as the surface of the water at the lowest stage. Low waters, such as now occur, would be impossible but for the fact that the river, in falling, cuts a channel for itself through these barriers. Were these natural channels suitable and sufficient for navigation, river improvement would be without its strongest claim to public support. They are unsuitable by reason of the uncertainty when and where they will form, and their frequent tortuousness. When they are deficient, it is usually by reason of a division of effort whereby two or more small channels are formed by an expenditure of the work which would suffice for a single one of sufficient size.

Above and on these shoals the contraction-works are to be placed. Their effect will be to localize and accelerate the natural channel cutting, but not to increase the amount of energy so expended. The amount of material scoured from the shoal nearly or quite equals each year the amount deposited on it. Otherwise the river would shut itself up. If so little as one per cent of the material deposited in a year on any shoal remained there permanently, the shoal would be raised perceptibly each year, and, within the recorded history of the river, should have become a dam as high as the banks, to turn the river out over the country. The regulated river, flowing through the contraction-works, can remove from the shoal each year but a small excess of material over what is deposited on it, and this for a limited period only: ultimately it can not, and by our hypothesis must not, carry away any excess.

It appears from the foregoing that the aggregate amount of material scoured from any shoal will not be sensibly changed by the contraction-works. The amount passing through in suspension cannot be affected at all: hence the total amount in suspension in the bend below will not differ. That the volume of water discharged will not be affected, it is scarcely necessary to argue. These two quantities unchanged, their quotient, which is the degree of satura-

tion, cannot be modified by the contraction-works: for their effect on the distribution of velocities in the bend below, it is only necessary to point to the portion of the river below Baton Rouge. Here the conditions prescribed for a regularized river obtain in greater perfection than can possibly be realized on the river above. Yet in this ideal stream the distribution of velocities follows the cart-wheel analogy as closely as anywhere else.

To sum up, the effect of the contraction-works on a shoal, upon the conditions existing in the bend below, is simply nothing, — nothing as to the distribution of velocities, and nothing as to the amount of sediment carried.

In the face of this conclusion, the changes required by our hypothesis, before it agrees to stop the caving, are quite discouraging. It asks nothing less than the complete reversal of present conditions. It requires that the restraint of a fundamental hydraulic law be removed, so that the water may move at the same velocity at bottom and surface. It demands that the rapid currents along the caving banks be checked, and the sluggish ones on the other side quickened; that sediment shall be deposited in places whence it is now removed, and removed from those where it is now deposited. These revolutions of the river's regimen, as results of works at a distant point, and which have, as has been shown, no effect upon the conditions to be changed, are severally and equally impossible. The greatest actual velocity will be found, as now, in front of the caving bank. If the lesser velocity at the contraction-works be sufficient to produce scour there, the greater velocity at the point of caving must also scour and the caving continue. If the velocity along the caving bank correspond to saturation, so as to prevent caving, the lesser velocity on the shoal must allow deposits, and navigation will be injured.

The disparity in velocities is utilized by steamboats, the down boats being assisted by the rapid currents in the bends, while the up boats take advantage of the slack water on the other side. Uniform motion all the way across would retard the former preceptibly, and the latter fifty per cent. It is now difficult to get up stream enough pieces to accommodate the down-stream traffic. With uniform motion, it would be impossible. Navigation will suffer by the most cautious bestowal of such benefits.

A more general view leads to the same result as the local one. Suppose the channel to have been regularized from Cairo to Baton Rouge as completely as it now is below the latter point. In this conduit, the water supplied by its tributaries is to flow under the conditions that it shall always have the normal charge of sediment due to the velocity, and that it shall neither erode the channel nor make any deposits therein. No sediment being derived from action on the bed, the supply must come entirely from the tributaries.

The tributaries differ widely in their turbidity. The Missouri is the largest silt contributor, furnishing much more than all the others together. After it, but still classed as muddy, come the small streams on the east side above Memphis, the Arkansas and the Red. The Ohio, St. Francis, White, and Yazoo are comparatively clear. If our regularized channel be adapted in size to carry Ohio water without scour or fill, deposits must result when the Missouri predominates. If the channel be such that Missouri water can be carried without loss or gain of sediment, scour and caving must be expected when the supply is mainly from the Ohio. If a mean be taken, the scour and fill will alternately occur, which is simply a relapse into the present difficulties. No natural adjustment by mixture is possible, since the streams named have drainage areas lying in widely different latitudes, and it is rarely that their rises or floods are co-incident.

Suppose, again, that the corrected channel just below Cairo is filled to a certain level with just the right mixture of Ohio and Missouri water, having the normal charge of sediment due to its velocity, and carrying it without loss or gain. A slight rise comes out of the Ohio. Bringing an insufficient supply of sediment, it reduces the degree of saturation in the trunk stream. In order that scour and caving may not begin, this addition of water must be accompanied by a decrease of velocity and a rise of surface. If the rise, on the other hand, comes from the Missouri, the case is reversed, and, in order to prevent deposits and shoals, the velocity must be increased without a corresponding rise in surface. To realize either set of conditions requires an inverse ratio between velocity and slope, which is a blow at the fundamental law of the universe, that of gravitation. These contradictory requirements are repeated all along the river's course. The Forked Deer, Obion, and Wolf Rivers must produce an effect on the main stream directly the reverse of the St. Francis; the Arkansas, of the White; and the Yazoo, of the Red. The velocity of the river must conform to the supply of sediment, or the hypothesis will be violated. The supply of sediment is fortuitous: hence chance must take the place of hydraulic laws in controlling the flow of the water.

There never has been a day in the known history of the river when caving was not in progress. The amount of sediment requisite to produce normal saturation and prevent caving must therefore be greater than the river has ever before carried. The demand is, that the river be made muddier, and kept so. How as to supply? Of the present contributions, a considerable part is to be cut off by the cessation of caving and scour, which are promised as results of the improvement. The tributaries remain; but of these, the only one worth considering, the Missouri, is already under improvement. The result of that improvement, if successful, will be a fixation of its bed, and a large reduction of its output of sediment. The maintenance of even the present supply of sediment in the trunk stream involves the degradation of the tributary. If the Mississippi is to be improved on such principles, the regulation of the Missouri must be stopped at once.

We see, that, while the demand for sediment is increased, the supply is largely reduced. A scheme of improvement, the vital feature of which is the production and maintenance of increased muddiness, promises as its results changes which must largely reduce the muddiness. Surely this is necromancy on a large scale.

The saturation hypothesis, whether true or false, and following it the anti-revetment theory and plan of improvement based thereon, must be entirely rejected so far as the Mississippi River is concerned; because the conditions under which it is claimed to act cannot be produced or maintained; because uniformity of velocity in any cross-section, or from one section to another, is impossible, either in natural or regulated channel; because the volume of water which controls the velocity, and the supply of sediment, the two factors which determine the saturation, are now practically independent, and in a regulated channel become absolutely so, thus making the combination of the two to produce normal saturation a matter of chance and not of law; finally and principally, because the hypothesis contradicts and defeats itself in that it requires an increased supply of sediment to produce results which, if realized, must make this supply a constantly decreasing quantity.

If the caving of banks is to be stopped, it must be done by means outside of the contraction-works, since the latter cannot produce the slightest diminution of caving. That they will greatly increase it, may be strongly argued both from theory and experience; but such is beyond the present purpose. SMITH S. LEACH.

MENTAL SCIENCE.

A Second Laura Bridgman.

THE recently issued report of the Perkins Institution for the Blind, where Laura Bridgman has spent fifty years of her life, adds another most interesting and promising record to the accounts of persons afflicted with this double infirmity. The number of persons deprived of both sight and hearing is larger than is commonly supposed, and gives no sanction to the common belief that the loss of one sense insures an unusually strong development of the others. From a psychological point of view, the value of such cases depends, first and chiefly, on the age at which the senses were lost, those cases being the most suggestive and valuable in which the loss is earliest; secondly, upon the degree of blindness and deafness, as well as the rapidity with which these senses lose their function, the most instructive inferences being deducible from cases in which the loss is total; and, thirdly, from the completeness and accuracy of the record of the person's capabilities and achievements at the various periods of life, and especially during early childhood. In all these respects the case of Laura Bridgman is a most phenomenal one. Her life-history is to the psychologist most fruitful of hints and suggestions, throwing clear light upon questions otherwise

difficult of approach. It is an experiment of nature, and as rightfully gets the eager eyes of the psychological student turned towards it, as the transit of Venus attracts the gaze of every astronomer's telescope. The majority of cases of deafness combined with blindness, however, do not belong to this category. In many instances enough remains of hearing or sight, or both, to allow these to enter as a factor in the mental development of the individual, and to that extent to vitiate the exclusive inference as to the *rôles* that these senses play in the psychic life. Often, too, though sight and hearing are practically totally lost, the loss occurred at a period of life when the mind has begun to profit by the experience which these senses collect, and can for many years feed upon the material thus brought together. This independence of the intellectual centres from their food-supply of sensations after a certain age — the fifth to the seventh year for sight — has been proved by actual observation. The report above referred to mentions that there are between thirty and thirty-five blind deaf-mutes in Sweden, where a benevolent lady has organized a school for such defections, and not less than forty such in this country. Eight of these are mentioned by name; but in only two of these cases is the age mentioned at which the loss of the senses occurred, — the one at eleven years, the other at seven, but with enough sight remaining to distinguish color, — and in both these, as well as in a third case, hearing was not lost until the power of speech had been permanently acquired. But of all these cases, hardly excepting that of Laura Bridgman, that of Helen Keller deserves the most minute and careful study. A *résumé* of the facts concerning her condition, collected by Mr. Anagnos, the director of the Perkins Institute, cannot fail to be of interest.

Helen is the daughter of cultured and well-to-do parents, and was born in Alabama on June 27, 1880. When about ninteen months old, she was attacked violently with congestion of the stomach; and to the effects of this disease are referred her total loss of sight and hearing. Previously she is said to have been of perfect health, and unusually bright and active. She had learned to walk, and was fast learning to talk. The loss of her senses thus took place about seven months earlier than in the case of Laura Bridgman, though Helen seems to have been as much if not more developed at nineteen months than was the latter at twenty-six months. In both cases a slow recovery was made, and a painful inflammation of the eyes set in. It is recorded of Helen that she "soon ceased to talk, because she had ceased to hear any sound."

As her strength returned, she gave ample evidence of the soundness of her mental faculties. She learned to distinguish the different members of her family and her friends by feeling their features, and took an especial interest in the affairs of the household. The little hands were constantly busy in feeling objects and detecting the movements of those about her. She began to imitate these motions, and thus learned to express her wants and meaning by signs, to a remarkable degree. Just before completing her seventh year, a skilful teacher from the Perkins Institute — Miss Sullivan — was engaged for her. At this age Helen is described as a "bright, active, well-grown girl," "quick and graceful in her movements, having fortunately not acquired any of those nervous habits so common among the blind. She has a merry laugh, and is fond of romping with other children. Indeed, she is never sad, but has the gayety which belongs to her age and temperament. When alone she is restless, and always flits from place to place as if searching for some thing or some body." Her sense of touch is developed to an unusual degree, and enables her to recognize her associates upon the slightest contact. Her sense of smell is very acute, enabling her to separate her own clothes from those of others; and her sense of taste is equally sound. In this respect she has an advantage over Laura Bridgman, in whom both these senses were reduced almost to extinction. She speedily learned to be neat and orderly about her person, and correct in her deportment. The first lesson is an interesting epoch. A doll had been sent Helen from Boston; and when she had made a satisfactory exploration of it, and was sitting quietly holding it, Miss Sullivan took Helen's hand and passed it over the doll; she then made the letters d–o–l–l in the finger-alphabet while Helen held her hand. "I began to make the letters a second time. She immediately dropped the doll, and followed the motions of my fingers with one hand, while she repeated the letters with the other. She next tried to spell the word without assistance, though rather awkwardly. She did not give the double *l*, and so I spelled the word once more, laying stress on the repeated letter. She then spelled 'doll' correctly. This process was repeated with other words, and Helen soon learned six words, — 'doll,' 'hat,' 'mug,' 'pin,' 'cup,' 'ball.' When given one of these objects, she would spell its name, but it was more than a week before she understood that all things were thus identified." In a surprisingly short time Helen completely mastered the notion that objects had names, and that the finger-alphabet opened up to her a rich avenue of knowledge. Every thing had to be named, and she seemed to remember difficult combinations of letters, such as 'heliotrope' and 'chrysanthemum,' quite as readily and securely as shorter words. In less than two months she learned three hundred words, and in about four months she had acquired six hundred and twenty-five words, — a truly remarkable achievement. She still used her gesture-signs; but, as her knowledge of words increased, the former fell into disuse. Next verbs were taught her, beginning with such as Helen herself could act, as 'sit,' 'stand,' 'shut,' 'open,' etc. Prepositions were similarly mastered. Helen was placed *in* the wardrobe, and the sentence spelled out to her. 'Box is *on* table,' 'Mildred is *in* crib,' are sentences which she constructed after little more than a month's instruction. Adjectives were skilfully introduced by an object-lesson upon a large, soft worsted ball and a bullet. Helen felt the difference in size at once. "Taking the bullet, she made her habitual sign for 'small;' that is, by pinching a little bit of the skin of one hand. Then she took the other ball, and made her sign for 'large' by spreading both hands over it. I substituted the adjectives 'large' and 'small' for these signs. Then her attention was called to the hardness of the one ball, and the softness of the other; and so she learned 'soft' and 'hard.' A few minutes afterwards she felt of her little sister's head, and said to her mother, 'Mildred's head is small and hard.'" Even so arbitrary elements of language as the auxiliary 'will' and the conjunction 'and' were learned before two months of instruction had passed, and on May 1 she formed the sentence, "Give Helen key, and Helen will open door."

From this the step to reading the raised type of the blind was an easy one. "Incredible as it may seem, she learned all the letters, both capital and small, in one day. Next I turned to the first page of the 'Primer,' and made her touch the word 'cat,' spelling it on my fingers at the same time. Instantly she caught the idea, and asked me to find 'dog,' and many other words. Indeed, she was much displeased because I could not find her name in the book." She soon added writing to her accomplishments, and carefully formed the letters upon the grooved boards used by the blind. On the 12th of July she wrote her first letter, beginning thus: "Helen will write mother letter papa did give helen medicine mildred will sit in swing mildred will kiss helen teacher did give helen peach," etc. This well justifies the statement that she acquired more in four months than did Laura Bridgman in two years. Letter-writing is quite a passion with her, and, as she is also able to write by the Braille system, she has the pleasure of being able to read what she has written. Her progress in arithmetic is equally remarkable, going through such exercises as "fifteen threes make forty-five," etc. As examples of her powers of inference, the following will do service: she asked her teacher, "What is Helen made of?" and was answered, "Flesh and blood and bone." When asked what her dog was made of, she answered, after a moment's pause, "Flesh and bone and blood." When asked the same question about her doll, she was puzzled, but at last answered slowly, "Straw." That some of her inferences are not equally happy, the following illustrates: "on being told that she was white, and that one of the servants was black, she concluded that all who occupied a similar menial position were of the same hue; and whenever I asked her the color of a servant, she would say, 'Black.' When asked the color of some one whose occupation she did not know, she seemed bewildered, and finally said, 'Blue.'" Her memory is remarkably retentive, and her powers of imitation unusually developed. One of her favorite occupations is to dress herself up, — a performance which she accomplishes not always with success according to our ideas. Her progress continues, and each letter is a marked improvement upon its predecessors. A letter to Mr. Anagnos contains

the following sentences: "My doll nancy is sleeping. She is sick. mildred is well uncle frank has gone hunting deer. we will have venison for breakfast when he comes home. I did ride in wheelbarrow and teacher did push it," and so on. Enough has been said to indicate the remarkable powers of this unfortunate child, and to give basis for the belief, that if her training is continued in a wise direction, and with a proper appreciation of the value of detailed and accurate investigation, the world will be able to read in the life of Helen Keller a most momentous psychological lesson.

EXPLORATION AND TRAVEL.

Tibet and Nepaul.

A SUPPLEMENT to the 'Indian Survey Report for 1885–86' has just been issued. It contains the description of a native surveyor, M—H, through eastern Nepaul and southern Tibet, of which the London *Times* gives the following extract: —

"The explorer crossed the Nepaul boundary near Dagmarathana, in Bhagalpur, and, after making customary presents, obtained a passport authorizing his further progress, which lay northward over the Mahabharat range, one of the spurs of the great Himalayan Mountains. At various points along the route his passport was examined, his goods searched, and a tax exacted from him, and in some cases he had, in addition, to propitiate the local authorities with presents. On July 24, 1885, the explorer passed a great temple, called Halsia Mahadeo, situated on a mountain-spur, and deputed his travelling-companion to visit and examine the temple, which is held in veneration in the neighborhood, and has been endowed with a large free grant of land. At Asaliakhark, a fort held by four hundred Nepaulese soldiers under a captain, whose duty it is to examine all passes brought by travellers from the south, and, after full inquiry, to grant fresh ones to those proceeding farther north, the explorer was subjected to much interrogation, as his pass was only available for Nepaul. As it was known that he intended penetrating northwards into Tibet, he was closely searched, interrogated, and directed to return by the way he came, the soldiers being ordered to keep him under surveillance for such time as he remained there. After being detained for six days, the explorer was able, by making suitable presents, to obtain permission to proceed, having persuaded the official that he and his party were inhabitants of Jumla, and that they were anxious to return thither by Dingri, Jonkhajong, and Kagbeni, as being the most expeditious route. Their further march lay pretty close to the Dudhkosi River, and at Jubang Tibetan inhabitants were met for the first time. Khumbujong, a little west of Mount Everest, is the residence of the governor of the Khumbu district. The official is a Tibetan, and has held the post for the last thirty years: he receives no pay from the Nepaul Government, but is allowed fifteen per cent of the net revenue of the district, and pays an annual official visit to Khatmandu. For a time the governor absolutely refused the party permission to proceed northwards by a route which he alleged had never till then been traversed by any Hindostanee or Goorkha. The explorer had therefore to make a lengthened stay at this place, during which he endeavored to ingratiate himself with the inhabitants by treating their sick. One of the commonest diseases in the locality was goitre, and, as he succeeded in curing the governor's daughter-in-law of this, he was naturally taken into favor, and secured the sympathies of her husband, Sunnam Durje. This last-named individual was about starting on a trading expedition to the north, and by the exercise of sufficient tact was prevailed upon to take the explorer's party in his train. The man eventually gained his father's tacit consent to the arrangement, and, after a six-weeks' enforced inactivity, the explorer again started on his way. On Sept. 23, near Pangji, the famous deity Takdeo ('horse-god'), a black rock, in shape like a huge horse, was passed. Out of deference to Takdeo, which is considered very sacred by the Tibetans, no ponies are allowed on the route over the pass. The Pangula Pass over the Himalayas, he says, is decidedly the highest and most formidable ever crossed by him: he estimates the height at over twenty thousand feet, but, owing to an unfortunate accident to his boiling-point thermometer, he was unable to estimate it more accurately. The ridge forms the boundary between Tibet and Nepaul. At Keprak, the first frontier village, the Tibetan official refused the party permission to go on, saying any such concession would cost him his life; but with the influence of their friend, Sunnam Durje, and by the exercise of a little diplomacy, a guide was eventually obtained to Dingri, across the great grassy plain called the Dingri Maidan.

"The town of Dingri, which has an elevation of 13,860 feet, consists of about two hundred and fifty houses, and the inhabitants are chiefly Tibetans, though there are five houses belonging to Goorkhas, and three or four to Chinamen, who have established themselves at this place for trading purposes. The houses are all stone-built, a tenacious whitish clay being used in place of mortar, and with flat roofs. The country round is well cultivated, but barley and peas are the only produce. The inhabitants all appear well-to-do. On the hill which rises immediately from the north of the town to a height of about three hundred feet, stands the stone-built fort occupied by the Daibung and forty Chinese officers, who are in command of about five hundred Tibetan soldiers. The Daibung is relieved once in three years, and during his tenure of office is allowed to trade within the limits of his province. There are said to be only three Daibungs, in all, under the Lhasa Government: of these, one resides in Lhasa, another in the Nam-Cho district, and the third at Dingri. The authority of the last mentioned extends from Shakia to the westernmost limits of Tibet, and he exercises both military and civil jurisdiction, short of capital punishment, within his territory. The trade in which the Daibung engages, so far as tea and salt are concerned, cannot be characterized as free. Each house in his jurisdiction is compelled to take one brick yearly from the Daibung at a high rate, and he realizes a large annual revenue from it. In addition to these two articles, he deals in blankets on the same footing as private traders. No gold is to be seen at Dingri: it is much sought after, and many inquiries were made of the explorer as to whether he had any gold, pearls, or coral to dispose of.

"The soldiers occupying the Dingri fort are armed with a sword, matchlock, and bow and arrows. The sword is the usual short, straight weapon, in wooden scabbard, met with all over Tibet; the matchlocks are sent from Lhasa; and the bows are made of bamboo which is brought from Nepaul. The soldiers manufacture their own powder on the spot. Lead is imported from Nepaul and Darjeeling; but, as bullet-moulds are unknown, they pour out the molten lead into a long, hollow scoop in the ground, and then clip it into convenient-sized pieces, which are hammered to suit the bores of the guns. The soldiers receive a small yearly pay (about £2 to £2 10s.), and are allowed to engage in agriculture, trade, etc. They are drilled by their Chinese officers every week or so, sometimes on foot, at other times mounted on ponies, which they maintain for themselves, and there are periodic inspections by the Daibung. At these inspections the soldiers always appear mounted, in uniform, and have to go through target-practice. For the latter a disk of leather, one foot in diameter, painted white, is suspended to a rope stretched across two poles. Each soldier in turn then rides full gallop across the field at about fifteen feet from the target, and fires as he goes past. Should he hit the mark, the officer in attendance with the Daibung scores a point. When all the soldiers have gone past in one direction, they return, firing in the same way as they go past the target, to their original position. They next go through the same course, using their bows and arrows instead of matchlocks. The Daibung then examines the notes of each officer, and for every point scored presents him with a khatag or kerchief. The explorer was not much impressed with the marksmanship he saw.

"As Dingri is situated on the high road from Lhasa westwards, it is the constant resort of traders, for whose convenience a serai capable of accommodating two hundred men has been built. The bulk of the goods is carried on mules, chiefly because they travel so much faster than either yâks or asses.

"Throughout the country from Bhagalpur to Dingri the chief articles carried northwards are tobacco-leaf, cotton-cloth, broad-cloth, iron, brass, and copper vessels, corals, and rupees, which are used for making jewelry; and for these the men of Khumbu go annually in parties to India, some even as far as Calcutta, taking with them musk-pods, yâk-tails, antelope-horns, blankets, and stuffed munal and argus pheasants. From Dingri are exported into Nepaul

Tibetan blankets, musk-pods, goats, ponies, clarified butter, and yâk-tails. The chief grain grown is maize or Indian-corn. The domestic animals comprise buffaloes, yâks, zobus (cross-breed between yâk and cow), goats, and sheep of the long-horned species, largely used in Tibet for transport purposes. The yâk and female zobu afford a plentiful supply of milk. Among the wild fauna are musk deer and Tibetan antelopes, while flocks of wild pigeons and ravens and pheasants are common.

"The Daibung was away when the explorer reached Dingri, and did not return till Oct. 21. Great trouble was experienced in getting him to accord permission for the party to proceed westwards. The Daibung declared that this route was absolutely closed to all but officials; but in consideration of the explorer's companion, who was a man of influence in these parts, and in consideration of his promise to be answerable for their good behavior, the required permission was granted, but with a proviso that from village to village a guide should escort the party and send back regular reports of the progress made.

"The general direction of the explorer's route then trended to the west, past the Palgucho Lake, about nine miles by four in extent, the waters of which are clear and sweet to the taste, though it has no outlet. The Tibetan fort of Jonkhajong, the farthest point to the north-west reached, is a substantial stronghold, about four hundred paces square, protected by a mud and stone wall. Two officials, called Jongpons (Tib. = 'governor of a district') reside here, and exercise civil and judicial authority short of capital punishment. The surrounding country appeared well cultivated, and the inhabitants were reaping their harvest at the time. The Jongpons gave permission for the party to travel to Nubri in accordance with the terms of the passport, but, as the route was reported to be closed by heavy falls of snow, it was only by more presents that a pass allowing M — H to proceed as far as Kirong was obtained. Beyond Kirong the route nears the river, and for about one hundred paces is carried over a gallery about six feet wide, run along the perpendicular face of the rock at a height of from fifteen to twenty feet above the water's edge. The gallery rests on thick iron bolts driven into the rock at intervals, over which planking is loosely laid: the outer edge is fenced by a rudely made rope passed round wooden posts fixed to the bolts. At Naiakot the route turned westwards, and, crossing the watershed of the Tirsuli River, descended into the valley of the Buri Gunduk, one of the chief rivers of Nepaul, which M — H ascended as far as Nubri, along a route nearly parallel with the line of his southward journey. Thence he retraced his steps along the Buri Gunduk to Arughat, a Nepaulese village, where the party were detained three days pending the result of inquiries as to whence they had come and for what purpose. The explorer professed to have gone all the way to Nubri in search of one of his dependants, who, he alleged, had run away from M — H's home in Jumla with a large sum of money some time before, but whom he had not succeeded in finding. He said that, having failed in his object, he was anxious to return home *viâ* Tirbeni, where he intended going through the customary religious observances. He was then allowed to proceed, but warned, that, owing to the disturbed state of the country consequent on the recent insurrection in Khatmandu, he was liable to detention in several places. His further route to Tirbenighat, on the British frontier, lay in a south-westerly direction."

ELECTRICAL SCIENCE.

Alternating Current Electro-Motors.[1]

THE alternating system of electrical distribution possesses many advantages for distributing electrical energy over extended areas; it has, however, certain disadvantages, among others that of not at present allowing the use of electric motors for the distribution of power.

In any central station supplying electric lights the full capacity of the plant is utilized but a short time during the twenty-four hours, and, taking the whole day, we will find that we have sold an amount of energy equal to a half or a third — perhaps even less — of the amount we could supply supposing we worked always at full capacity.

If we draw a curve representing the energy used at different hours of the day for lighting, it will be something like *O D E H F G X* in Fig. 1. The total amount we could have sold is *A O X B*. If we can use motors on the circuit, we can sell an additional amount of power such that the power used for lighting and by the motors never exceeds the maximum capacity of the station. For instance, if the motors work until 6 P.M., we can use for them a horse-power equal to *H I*, and the total energy we can sell for the motors is *H I K L*. The solid part of our diagram is all of the energy that a purely alternating system can expect to utilize: a continuous current system, by employing storage-batteries, could fill the whole of the area *A O X B*.

In the alternating system the current and electro-motive force may be represented by the curves I and II, Fig. 2, the maximum

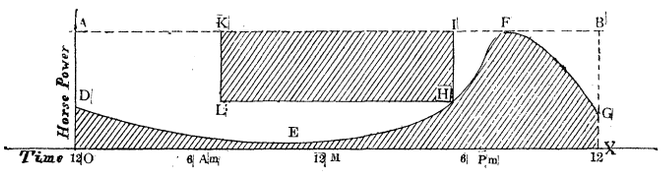


FIG. 1.

value of the current lagging behind the maximum of the electro-motive force. In the main circuit a high electro-motive force of constant maximum value is used, and this is reduced at points of consumption to the low potential necessary for safety, and for use with incandescent lamps, by 'transformers;' that is, by 'induction-coils' working backward. The value of the system lies in this: by using high potentials in the main or primary circuit, we can transmit a great deal of energy with comparatively little current, and therefore with little loss in the lines. This enables us to use small conductors, and avoid the large investment in copper necessary in distributing energy by the direct system.

If we can use motors in this system, we can almost double our receipts with comparatively little increase in our expenses. The plant remains the same; the salaries, interest on investment, and depreciation, are only slightly increased; our main additional expense is for the fuel.

The forms of motors that can be run by alternating currents are (1) an ordinary series-wound motor; (2) a motor built like an alternating current dynamo, the field-magnets being excited by the

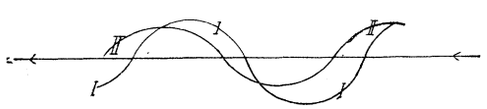


FIG. 2.

alternating current, which is first commutated so that its direction is always the same; (3) the same arrangement as the last, except that the field-magnets are excited by a continuous current from some external source; (4) the form proposed by Prof. E. Thomson, in which the armature currents are not supplied from any external source, but are induced in them by the alternations of the field-current.

Of these forms, (3) appears the most promising. Its advantages are, that when it is once started it will perfectly govern itself, revolving at such a speed that its own reversals of electro-motive force occur with the same rapidity as those of the dynamo driving it; it is cheap to construct, and durable; and it should be efficient, and give a greater output than corresponding machines of the other types. Its disadvantages are, that it must be first driven to its proper number of revolutions before the alternating currents will run it; there must be some external source of continuous current to excite the field-magnets; and if a load possessing any considerable inertia be suddenly applied, the motor will stop.

It is proposed to avoid these difficulties in the following way:

[1] Abstract of a paper read before the American Institute of Electrical Engineers, by Dr. Louis Duncan, Johns Hopkins University.

with the main circuits there should be run an auxiliary continuous current circuit from the central station, of a capacity of, say, ten per cent of the power to be supplied. This continuous current would have two uses: in the first place, it would excite the field-magnets; and, in the second, it would start the motor. This last could be accomplished by having a commutator on the motor-shaft that would reverse the current through the armature every time an armature coil passed a pole. Now, by a simple switch, we could first turn on the continuous current, which would start the motor, and then, when the armature had reached its proper number of revolutions, we could turn the handle a little further, and make the alternating circuit through the armature, at the same time breaking the continuous circuit.

To prevent the stopping of the motor on the sudden application of a load, there should be some form of friction-pulley on the shaft that would turn just before the motor had passed its maximum possible work.

The easiest way to decide which of the possible forms of motor is best, is to experiment on them all. It is not necessary to experiment on a number of motors of each form; but if we make suitable observations, and know how to draw deductions from our results, we can tell very closely, from experiments on one motor, what are the capabilities of the type.

GAS-ENGINES AND WIND-MILLS FOR ELECTRIC LIGHTING. — Up to the present there have been few private houses supplied with electric lights. The central stations have been placed in the more crowded business portions of the towns, and lights have not been distributed at great distances from them. There are other reasons why incandescent lights have not been more rapidly introduced: the general public has not had sufficiently brought before it the advantages of electric lighting over gas from an artistic and hygienic point of vlew; it has been considered mainly from the standpoint of cost as compared with gas. In many cities gas is supplied over extended areas, embracing sometimes the suburbs for miles around. For the more wealthy suburban inhabitants it would be easy to light their houses by electricity, using a gas-engine for power, and employing a storage-battery in connection with the dynamo. Some figures obtained at the late electrical exhibition in New York will be of interest. We find, if we consider a five-foot gas-burner as giving a light of 16-candle power, that 130 feet of gas supplied to a gas-engine will give as many incandescent lamps, these being fed directly from the dynamo, as would 150 feet of gas burned directly. If we use a storage-battery, and allow it 70 per cent efficiency, we have 30 incandescent lamps using 186 feet of gas, to 150 feet for the gas-burners. To the expense of the electric light, moreover, we must add the interest on the plant, depreciation, breakage of lamps, etc. These items will perhaps double the expense of the electric light. The cost could, however, be reduced if two or three people living close together would use the same plant: it could be still further reduced if cheap fuel-gas could be supplied for the engine. As far as cost goes, then, the electric lights supplied in this way would be more expensive than gas; but for people of means, the greater beauty of the light, and its healthfulness, together with the many smaller offices the electricity could be made to perform, would repay the increase in cost. Where there is no gas, it has been proposed to use wind-mills. Mr. A. R. Wolff states that a properly constructed wind-mill will govern itself for all velocities of wind exceeding six miles per hour; further, that on the average, for at least eight hours out of twenty-four, the wind exceeds this velocity. "Total calms in excess of two days' duration are practically unknown in the United States." If these figures are correct, it is evident that we can use wind-mills in connection with storage-batteries for supplying light to country houses. It should be borne in mind, however, that isolated plants of this kind must have a capacity very much greater than the mean power required; and in this case, where we may have calms of two or perhaps three days' duration, the capacity must be sufficient to last over this time. Counting the interest and depreciation, and the breakage of lamps, it will probably be found that the cost will be greater than that of oil; but there is no comparison as regards convenience and beauty, and it is probable that the wind-mill will be used as a source of power for lighting the houses of rich country people.

ETHNOLOGY.

Christmas Customs in Newfoundland.

THE Rev. Moses Harvey of St. John, Newfoundland, describes in the *Montreal Gazette* an interesting Christmas custom observed in Newfoundland. Formerly, he says, at this season, 'mumming' was carried on to a large extent; but the practice at last became an intolerable nuisance in the streets, and was put down by law. Firing salutes on Christmas Day, once a general custom, has also been prohibited, to the greater comfort of every one. A curious custom prevailed here on St. Stephen's Day (Dec. 26). It was called 'The Burying of the Wren.' Bands of boys and youths, with some rude musical instruments, went about the streets on that day carrying a green bough, to which were fastened ornaments of colored paper and either a dead bird or the figure of one. They called at the doors as they made their rounds, and sang a rude doggerel, of which the following was the burden: —

"The wren, the wren,
The king of all birds,
On St. Stephen's Day
Was caught in the furze.
Though he is little,
His honor is great,
So rise up, kind lady,
And give us a treat.
Up with the kettle
And down with the pan, —
A penny or 'tuppence'
To bury the 'wran.'"

The contributions thus levied by the youngsters were spent in the purchase of cakes and sweetmeats.

The custom is now almost extinct, but some faint and forlorn attempts are still made by a few boys to keep it up, and in a few years it will probably pass into oblivion. It is curious to find that a similar ceremony was once practised in the Isle of Man. In Waldron's works, published in 1711, in describing the Isle of Man, the author says, "Here, on the 24th of December, towards evening, all the servants have a holiday. They go not to bed all night, but ramble about till the bells ring in all the churches, which is at twelve o'clock. Prayers being over, they go to hunt the wren, and, having found one of these poor birds, they kill her and lay her on a bier with the utmost solemnity, bringing her to the parish church, and burying her with a whimsical kind of solemnity, singing dirges over her in the monks' language, which they call her knell, after which Christmas begins." It is evidently the same ceremony, in an altered form, that is practised here. What is its origin, how it came here, or whether it is kept up elsewhere on this side of the Atlantic, is not known.

BOOK-REVIEWS.

Harvard Reminiscences. By ANDREW P. PEABODY. Boston, Ticknor. 12°. $1.25.

THIS work, by the venerable professor of Christian morals at Harvard College, will be of much interest to graduates of the college, both younger and older, and by no means devoid of interest to the general reader. The author's reminiscences relate to the time when he was undergraduate, theological student, and tutor, but do not cover the period of his professorship, which he has now held for so many years. The state of things at Harvard in those olden times was so different from the present, that we can hardly repress a smile as we read of it. Thus, Dr. Peabody tells us that a student's room was usually destitute of all the means of comfort, and even of the tokens of civilization; that carpets were almost unknown, and friction matches entirely so; and that the entire furniture of the room, except the feather-bed, would not have sold for more than ten dollars. The relations between professors and students is described as one of mutual hostility; the students, in particular, considering the faculty as their natural enemies. As regards study, Dr. Peabody thinks that the best scholars did more work, and the poorer ones less, than they do now. The administration of the college affairs is described as loose and unbusinesslike until the elevation of Josiah Quincy to the presidency, when a thorough reform was carried out under that distinguished leader, whose pre-

vious experience as member of Congress and mayor of Boston had eminently fitted him for the work. Dr. Peabody gives many interesting accounts of the modes of teaching and lecturing pursued by the professors of whom he speaks, some of which are full of suggestiveness even now. He gives his personal recollections of nearly seventy men who held offices in the college, with excellent sketches of character and interesting anecdotes; and, though some of those of whom he speaks were hardly known outside the college, not a few had a national reputation. It is hardly necessary to add that the venerable author writes, as always, clearly and with hearty nterest in his subject.

The National Sin of Literary Piracy. By HENRY VAN DYKE. New York, Scribner. 16°. 5 cents.

THIS pamphlet is a vigorous protest against the absence in this country of an international copyright law, and against the unwillingness of our people up to this time to enact such a law. There is nothing in the author's argument that is specially new; but the moral principles involved in the subject have seldom been exhibited with greater force and clearness than they are here. Mr. Van Dyke's essay was originally a sermon, and the mere fact that a sermon on the subject could be preached to a popular audience is proof that public interest in the question is already awakened. The author treats the subject from a moral standpoint, maintaining that we have no more right to take a foreign author's work without paying him for it than we have to take any other man's work, literary or otherwise, in the same way. He treats as irrelevant the argument, sometimes adduced by the opponents of international copyright, that the American people want cheap literature. "The question is," he remarks, "how do they propose to gratify that desire, fairly or feloniously? My neighbor's passionate love of light has nothing to do with his right to carry off my candles. The first point to be determined is one of righteousness." He holds, however, that the republication of foreign works is not only wrong, but injurious to our own people, both by hindering the growth of our national literature, and by helping to weaken the national conscience. The book will be found interesting by all who are interested in the subject, and, if read by the right persons, can hardly fail to have some effect on public opinion.

Chemistry, Inorganic and Organic. By CHARLES LOUDON BLOXAM. 6th ed. Philadelphia, Blakiston. 8°. $4.50.

THE appearance of the sixth edition of Professor Bloxam's well-known work follows closely upon the announcement of the death of the author. The general character of the work, its elaborate display of experiment, and practical intent, are the same as in previous editions; but much of the text has been re-written, and the whole revised and passed through the press under the author's own supervision. Much new matter has been incorporated (some of date even so late as the recent isolation of fluorine), and the part which deals with organic chemistry has been recast with a view to bringing theoretical relations more clearly to light. The technological applications of organic chemistry receive considerable attention, and the subject of explosives. In the previous editions, the work has been a favorite, particularly with practical men and students of applied chemistry. The present edition is an improvement upon its predecessors, and a fitting memorial of its lamented author.

Benjamin Franklin as a Man of Letters. By JOHN BACH MCMASTER. Boston, Houghton, Mifflin, & Co. 16°. $1.25.

FRANKLIN'S name has always stood side by side with that of Washington; and there are no other Americans, except perhaps Lincoln and Grant, whose deeds and character are equally well known to the mass of their countrymen. But Franklin's greatness was chiefly in the fields of politics and science, and it is chiefly as politician and scientist that he is generally known; while his strictly literary works, except the autobiography, are much less read than those of many men who, on the whole, are his inferiors. Yet his literary merits are not slight, and the influence of his writings on the opinions and tastes of his contemporaries was great. He was not only the author of the autobiography and of several scientific papers, but he was also the first great American journalist; and in all these capacities he deserves grateful remembrance. It was necessary, therefore, that in a series of works devoted to American men of letters he should have a prominent place, and the sketch of his literary work which Mr. McMaster has written is in most respects worthy of its theme. It gives, perhaps, too little space to the political papers which Franklin wrote so abundantly, and which often had great influence on public opinion and on the course of events. Many paragraphs, too, of Mr. McMaster's work are filled with mere lists of articles that Franklin wrote; and these passages could well have been spared in favor of something more important. Nor do we find so good an account of the development of Franklin's mind and character as we could have wished. Yet, in spite of these defects, the book gives an interesting account of Franklin's writings, with a mass of details relating to his life, his business, his associates, and, in short, every thing connected with his literary work. The result is a work which, as an account of Franklin's place in literature, is not likely to be surpassed.

Franklin's career has always been an example and an incentive to boys and young men that have had to struggle upward from humble beginnings, and deservedly so; for, considering the times in which he lived, his success in politics and science and literature, as well as in acquiring a fortune, was indeed surprising. Mr. McMaster, however, agrees with all other good judges, that Franklin's morality was not of a high order, and that in this respect his life and his philosophy are not what might be wished. "His philosophy," our author remarks, "was the philosophy of the useful; the philosophy whose aim it is to increase the power, to ameliorate the condition, to supply the vulgar wants, of mankind. . . . Morality he never taught, and he was not fit to teach it" (pp. 277, 278). With regard to his electrical discoveries, Mr. McMaster expresses the opinion that Franklin was considerably indebted for valuable hints to his friend Ebenezer Kinnersley; but he does not specify the particular contributions that Kinnersley made to the subject. The author points out, too, in another place, that the plan for a union of the Colonies, which Franklin proposed at Albany at the beginning of the French and Indian war, was borrowed from Daniel Coxe, who had proposed the same plan many years before, when Franklin was a boy. Mr. McMaster's judgment on Franklin considered as a writer only is likely to be generally accepted, and is in brief as follows: "The place to be allotted Franklin among American men of letters is hard to determine. He founded no school of literature. He gave no impetus to letters. He put his name to no great work of history, of poetry, of fiction. Till after his day no such thing as American literature existed. . . . His place is among that giant race of pamphleteers and essayists most of whom went before, but a few of whom came immediately after, the war for independence. And among them he is easily first" (pp. 272, 273).

A Text-Book of Inorganic Chemistry. By VICTOR VON RICHTER. Tr. by Edgar F. Smith. Philadelphia, Blakiston. 12°. $2.

IT is not surprising, however much to be deprecated, that the elementary literature of branches of knowledge like chemistry, which, constantly expanding, are frequently brought to public notice, and so made attractive to the popular imagination, should be perennially deluged by the products of the misguided passion for authorship; nor ought it to be unexpected that the great majority of the many text-books of chemistry, general and applied, which come to the light, should shortly disappear utterly from the notice of an intelligent public. The occasional varying of the usual monotony by the appearance of a work of real value to student and instructor, which proves its claim to appreciation by survival in the competition with its fellows, is refreshing. Richter's text-books are of this sort, and the volume before us represents the third American edition, based upon the fifth edition of the German original.

The scheme of development follows the order of the 'periodic law,' and the introduction of theory is gradual and opportune. Thus the reader is brought directly into contact with the laws of definite and multiple proportions and the conception of atoms and molecules only when the demonstration of the properties of the halogens leads to the point. So, also, the questions of valence and structure wait the presentation of facts with sufficient fulness to

show the necessity and worth of the hypotheses advanced. Throughout the inductive method of thought is predominant; but whether the impression left upon the mind of the average student by the disconnected introduction of principles is broad and clear, may be questionable, though the threads are, at least, left in such relation that they may be easily gathered up and properly interwoven.

Thermochemical phenomena claim very considerable attention from the outset, and re-actions are discussed in the light of the law of maximum work. Sometimes, indeed, as it seems, this principle is forced beyond its depth, and phenomena are made to appear as effects of an unvarying law, rather than as illustrations of a principle which has come to be regarded as of by no means universal application. In the main, the spirit of the book is scientific. It is full and minute in the description of processes and facts, well abreast with the times, and for the most part logical and clear, though occasional crudities in the use of English, and now and then an actual lapse from grammatical accuracy, mar, without excuse in a third edition, the general effect. Such faults, though rather less numerous than in the second edition, are particularly noticeable just where they are most undesirable, — in the passages which deal with theories and principles, — and are to be credited largely to the tendency of the translator to cling to the literal rendering of the original rather than strive for an intelligible version. We note with mingled feelings the slight — too slight — improvement over the second edition in the matter of the plate of spectra.

Woman and the Commonwealth. By GEORGE PELLEW. Boston, Houghton, Mifflin, & Co. 8°. 25 cents.

THE pamphlet here before us is a plea for woman suffrage; but we doubt if it will have much influence in promoting its object. The author is so violent a partisan, and so governed by sentiment, that what he says is more likely to repel than attract those whom he wishes to convert. He goes so far as to declare that women are superior to men, both intellectually and morally, and holds that woman's influence in politics would be both purifying and elevating. He examines some of the arguments that have been adduced on the other side, and answers some of them very conclusively; but his reply to others can hardly be considered satisfactory. Moreover, he does not notice what is to many men the chief objection to woman suffrage; namely, the danger that women would be liable to use their political power to enact moral reforms by law, to the great detriment of politics and of morality. There are good things in the pamphlet, however, and those who already agree with its views will doubtless take pleasure in reading it.

NOTES AND NEWS.

THE first number of *The American Anthropologist* has just been issued. It is highly gratifying to record the establishment of a journal of this scope and character, as it is a sure sign of the growing interest in anthropology. The Anthropological Society of Washington, under whose auspices the journal is published, must be congratulated in its new enterprise, which will be highly welcomed by all students of the science of man. The papers contained in the first number show that the journal will embrace all the numerous branches of anthropology. Dr. James C. Welling contributes an inquiry into the law of Malthus; and it is significant of the Washington school of anthropologists that the first paper is devoted to a study in sociology. Col. F. A. Seely, who has so successfully applied the methods used by the Patent Office for tracing inventions to ethnological questions, gives a review of the development of time-keeping in Greece and Rome. Dr. Frank Baker's 'Anthropological Notes on the Human Hand' deals not only with the physiognomy of the hand, but also with current and ancient beliefs referring to the hand. The last paper of the number is a study of the Chane-abal tribe and dialect of Chiapas, by Dr. D. G. Brinton, in which the learned author compares the extant relics of that language, and gives it its proper place among the Maya dialects. Among the articles promised for future numbers, we notice papers by Maj. J. W. Powell, 'From Barbarism to Civilization;' H. H. Bates, 'Discontinuities in Nature's Methods;' and Dr. A. B. Meyer, 'The Nephrite Question.'

— A despatch from Zanzibar says that messengers from Emin Pacha who passed Uganda on Nov. 17 had no news whatever from Stanley, and that no news of his approach had been received in Wadelai. Further, it is stated in the telegram that King Mwanga has taken a friendly attitude towards Europeans. As Wadelai is only twelve days distant from Uganda, it appears that Stanley had not reached Emin's province in the middle of October. The next mail from the Kongo, which is due towards the end of this month, will probably bring some information regarding the events at Stanley Falls and at the mouth of the Aruvimi, which must have been of some influence upon Stanley's expedition. It seems unnecessary, so far, to entertain serious apprehensions as to his safety.

— "A large circle of admirers, both English and American," says the *Pall Mall Gazette*, "will see with pleasure that the Murchison medal of the Geological Society is to be conferred this year on Dr. J. S. Newberry of New York, the well-known professor of Columbia College. Dr. Newberry, however, has been in his time active, and indeed distinguished, in other matters besides geology. 'I remember,' writes a correspondent, 'meeting him by chance in Nashville in November, 1863, when he was at the head of the Western department of the Sanitary Commission, — an immense organization whose business it was to dispense, for the benefit of the soldiers of the Republic, great quantities of stores, consisting mainly of medicines, clothing, and comforts of all sorts, subscribed by enthusiastic citizens of the Northern States. Dr. Newberry took me down with him from Nashville to the then seat of war, on the boundary of Georgia, and I can bear witness to the workmanlike manner in which he administered his department, and the devotion with which he was regarded by all his assistants."

LETTERS TO THE EDITOR.

Errors in 'The Ancient Monuments of the Mississippi Valley.'

IT is an ungracious task to criticise at this late day the work of Messrs. Squier and Davis, which has so long been received as the standard on North American archæology; nevertheless I believe the result will be accepted as a sufficient justification for the attempt.

It is stated in the text (p. 68), under the heading 'The Newark Works,' that the circular structure *E* "is not, as has been generally represented, a true circle; its form is that of an ellipse, its diameters being twelve hundred and fifty feet and eleven hundred and fifty feet respectively. . . . The area of the enclosure is something over thirty acres."

A short calculation will make it evident that an ellipse having the diameters given above will enclose only twenty-six acres. We also notice, that, notwithstanding the authors' statement in the text, their plate (XXV.), which is copied from Colonel Whittlesey's survey, makes the shorter diameter (Section *C–D*), 1,200 feet.

A careful resurvey by the agents of the Bureau of Ethnology makes the diameters 1,205 and 1,197 feet, the latter differing but three feet from Colonel Whittlesey's measurement. The figure is therefore very nearly a true circle, the difference between the diameters being only eight feet, instead of one hundred as given by Squier and Davis.

They also state that the circular enclosure *F*, which connects with the Octagon, "is a true circle two thousand eight hundred and eighty feet, or upwards of half a mile, in circumference." This gives a diameter of but 917 feet, while the section *A–B* of the plate makes it 1,050 feet, — measuring from the gateway to the observatory, — a difference of one hundred and thirty-three feet between the text and plate. According to the survey made by the agents of the bureau, this diameter is 1,058 feet, and the one transverse to it 1,054 feet; the figure varying, in fact, but little from a true circle.

It appears from these facts that the authors, although adopting Colonel Whittlesey's survey in their plate, have differed from it in their text without a word of explanation, the variation in each case being a blunder on their part.

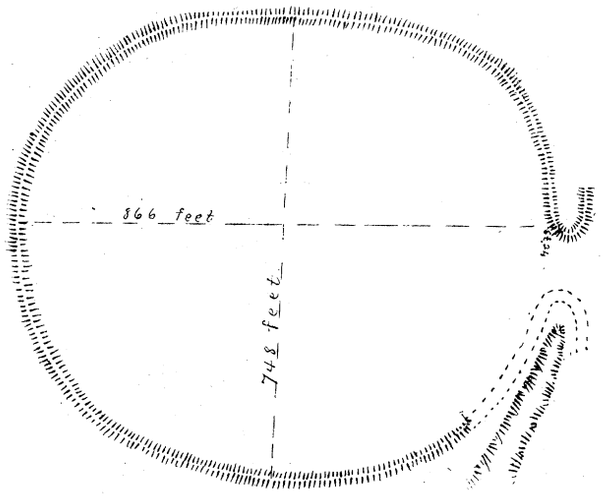
The area of the Octagon, as shown by the resurvey, is but a small fraction over thirty-six acres, including the inner halves of the walls; whereas it is given on the plate as fifty acres, and in the text as "something over fifty acres."

It is apparent that these mistakes cannot be attributed to typographical errors or mere slips of the pen. We are forced, therefore, to ascribe them to unpardonable carelessness.

Turning to their Plate XX., representing the ancient works in Liberty Township, Ross County, we find in a supplementary plan (*A*), a diagram showing their method of surveying circles, of which an explanation is given in a footnote on p. 57. In this note the authors say, "To put at once all scepticism at rest, which might otherwise arise as to the regularity of these works, it should be stated that they were all carefully surveyed by the authors in person." After mentioning their method, they add, "The supplementary plan *A* indicates the method of survey, the 'Field-Book' of which, the circle being thirty-six hundred feet in circumference, and the stations three hundred feet apart, is as follows," etc.

It is certainly disappointing, after this positive assurance of accuracy in their work, and reference to the 'Field-Book,' to find that the circle used in this illustration of their method is purely an imaginary one, as there is no circular enclosure of the dimensions given, either figured or mentioned in their book.

Another reason for being disappointed where such precision is predicated is the fact, ascertained by examination of the works, that



this plate is turned one-quarter round, the left of the page being north instead of the top. Moreover, this error is carried into the plat; the direction of the wall of the square marked 'N. 45 E.' being in truth S. 45 E., and of that marked 'N. 45 W.' being N. 45 E: in other words, the large circle is south of the square, and not east of it as represented in the plate.

A resurvey of the smaller circular enclosure, the only one of the group remaining, proves that it is far from being a true circle. This is clearly shown by the following list of external angles made by the successive chords with each other; or, in other words, the differences in the bearings of the successive chords. The survey was made precisely as suggested by Squier and Davis, except that the chords are each one hundred feet, thus bringing them within the length of a single chain. A gap of 343 feet is omitted, as the wall over this space is too nearly obliterated to be traced satisfactorily.

21° 35′	4° 45′	17° 37′	14° 43′	13° 13′	7° 30′	25° 19′
3 09	10 44	11 35	13 54	17 18	2 63	19 10
20 31	17 16	18 35	19 28	15 29	5 57	12 55

The first course (from Station 1 to 2) was S. 60° W.; from 2 to 3, S. 81° 35′ W.; and so on around, making one hundred feet at each step to Station 23; from 23 to 24, S. 1° 58′ W., 30 feet; from 24 to 1, S. 23° 20′ W., 313 feet. These figures make it clear that there are sharp curves at some points, and nearly straight stretches at others. I insert here a diagram of this so-called perfect circle prepared by Mr. Middleton, who conducted the survey. It will be seen from this that not only is it irregular, but that the longer diameter is 866 feet and the shorter 748, — a difference of 108 feet.

Although there are some puzzling questions connected with these Ohio works, yet it is apparent that the mathematical accuracy of which Messrs. Squier and Davis speak is imaginary, and is based, in fact, upon hypothetical figures. But the worst feature of the case is the evidence thus brought to light of the want of care in their work, thus shaking the confidence which has hitherto been reposed in it. Their allusion to a 'Field-Book' in connection with a purely imaginary circle, is, to say the least, misleading.

CYRUS THOMAS.

Youngsville, Penn., Feb. 8.

Cat Phenomena.

A YOUNG male cat, from the first quite secluded from other associations than those of his home, exhibited great fondness for bottled Tuscan olives when first offered this fruit, eagerly eating it, and rubbing his head and rolling upon the floor where it was dropped. This is repeated on every occasion since. His appetite for olives is seemingly insatiable, and experiments show that it is not because these are salted. He is indifferent to the ordinary culinary aromatics and toilet perfumes. What aromatics are used in the 'aromatized sea-salt' said to be used in the foreign pickling of olives? None are spoken of in the California processes, which, however, include marine salt; but this can have no pertinence to cat-senses. Have others observed the appetite, and will any one who can try cats with unpickled olives, both green and ripe, report the result? The subject has bearings on animal sensation and its relations. A series of various experiments, shutting out the possibility of artificially acquired individual appetites for flavors and odors, would be interesting.

As related to other considerations, it may be mentioned that the cat above referred to, the second time it was offered meat in its early kittenhood, and with a peculiar call therewith for the first time repeated, ran to the meat. Later, after a child had several times tickled the cat's feet by reaching under the open-work weaving of a cane-seat chair on which the animal was sitting, the cat was a number of times observed to repeat the kicking and shaking of its feet on a similar chair with no such stimulus, no person being near the chair. The titillation had become speedily associated with the touch of the cane-seat itself. These facts illustrate the quick and permanent sense-associations of animals, which are the secret of the formation of instincts (along with variation of acts and Darwin's theory of the natural selection of the same), and also of many alleged novel or isolated acts that are construed as rational.

Inherited domestic instinct was shown by the same cat, when, in its early and feeble wanderings as a kitten about the room, it sought a door with signs of a desire to have it opened. From accompanying circumstances, it was inferred that this was connected with some severe lessons on the necessity of personal neatness inflicted on some unknown ancestor: at all events, it seemed to be an inherited sense-association of some kind with the door, and suggests that many so-called 'intelligent acts' may be of this character.

A fact opposed to perception as always the stimulus to instinct is every day verified by this cat, now nine months old, in his vigorous pawing of the wooden box itself and the adjacent wall, after using the dry earth in his large, shallow sanitary box. The perception of soil, rather than of hard box and wall, should alone stimulate the instinct, if such mental act is necessary. In the act of preparatory digging, the perception of soil is manifest. It is absent in the covering process, as above shown; also in the same cat's frequent attempts to cover such food as it refuses at its usual place of feeding, by scraping the oil-cloth of the floor. There is, however, perception as well as sensation in the act of this and other cats when pausing to smell around and locate anew the matter to be covered. The process of covering is the most wonderful part of the instinct, and originally must have been the last acquired: in some cases it seems to be more or less lost; in the same individual cases it is at times omitted or little fulfilled. It is purely automatic. The wonder is, how, in the wild state, it was ever of enough consequence to cats and dogs to be acquired by natural selection; and how it was of sufficient consequence to be thoroughly acquired as automatic, while at the same time it is so poorly ingrained as to habitually blunder, and even fall into much disuse, in some cases. H. W. PARKER.

Grinnell, Io., Feb. 9.

The Nutriment in Edible Fungi.

IT is a favorite theory with some that the nutritive value of many of the fungi that are used as food is almost equal to the nutritive value of meat. A recent statement by the eminent chemist of Germany, Mr. C. T. Morner, is to the effect that the total nitrogen in this class of fungi varies between 2 and 3.64 per cent in the dry material; that 41 per cent of the total nitrogen is useful in alimentation; that all the rest belongs to non-assimilable bodies; and that, notwithstanding the relatively high figures, fungi constitute a very mediocre food, since the figures relate to dry material, and fungi contain enormous quantities of water. Mr. Morner, in this connection, gives a number of tables which show the amount of the several fungi that would be required to equal a pound of beef: mushrooms, 9 pounds; *Lactarius deliciosus*, 24 pounds; chanterelle, 41 pounds; morel, 15 pounds; *Polyporus ovinus*, 67 pounds.

Some recent experiments at the agricultural experiment station of the State of New York do not appear to sustain the statements of Professor Morner. A quantity of mushrooms (*Agaricus campestris*) growing in a pasture was gathered and subjected to an analysis, and the digestibility of the albuminoids determined by the pepsin method. The results were as follows:—

	Fresh Substance.	Water Free
Water	89.15	....
Ash	.85	7.80
Albuminoids	6.08	56.00
Crude fibre	.76	7.05
Nitrogen-free extract	2.27	21.83
Fat (ether extract)	.79	7.32
Total nitrogen		8.96
Albuminoids digested		84.50

The total nitrogen found in the dry substance was about 2.5 times as great as the highest figures given by the German chemist, while the digestibility placed it among the exceptionally rich nitrogenous foods. Experiments were also made with puff-balls. A very large one was found to have been broken into many fragments by careless handling. Many of the broken fragments were gathered together and taken for analysis. This specimen was in fine edible maturity. Another fresh one, a fine large specimen of *Lycoperdon giganteum*, was examined. The following measurements were taken in connection with the analysis: greatest diameter, 12.5 inches; height, 7.5 inches; horizontal circumference, 37.25 inches; vertical circumference, 33.5 inches; weight, 2,864 grams, or 6.35 pounds. The puff-ball was kept until the following morning before examination, when it was found to have lost 5.93 per cent by weight. A slice from the centre was taken for analysis. This contained 92.18 per cent of water. In the following table, No. 1 refers to the whole puff-ball, which was larger and more mature than No. 2, the broken one.

	No. 1.		No. 2.
	Fresh Substance.	Water Free.	Water Free.
Water	92.18	....	....
Ash	.58	7.47	6.97
Albuminoids	5.19	66.34	57.44
Crude fibre	.89	11.42	11.07
Nitrogen-free extract	1.05	13.33	22.05
Fat (ether extract)	.11	1.44	2.47
Total nitrogen		10.63	9.19
Per cent albuminoids digested		70.04	81.72

The total nitrogen for one of the puff-palls was about three times as great as the highest figures by Morner; and, even with the large percentage of water, it compares favorable in nutritive value with meat. It would seem, from the analyses which were made at the station, that Morner's specimens must have been very poor ones, or else the fungi in Germany are not so rich in albuminoids as those growing wild in the State of New York.

FREDERIC G. MATHER.

Albany, N.Y., Feb. 14.

A Worm in a Hen's Egg.

ON Sunday, Feb. 12, 1888, a lady in this city, on opening the egg of an ordinary hen, observed a worm lying coiled in the albumen or 'white' of the egg, near the lesser or pointed end. She placed the egg in a saucer, and the albumen flowed out through the opening in the shell, carrying the worm with it. After exhibiting to friends during the day, it was brought to me, Feb. 12. Upon examination, I find it to be an *Ascaris lumbricoides* about four inches in length; and, with the statement verified, the phenomenon becomes interesting in many ways.

G. C. ASHMUN.

Cleveland, O., Feb. 14.

Self-Recording Rain-Gauge.

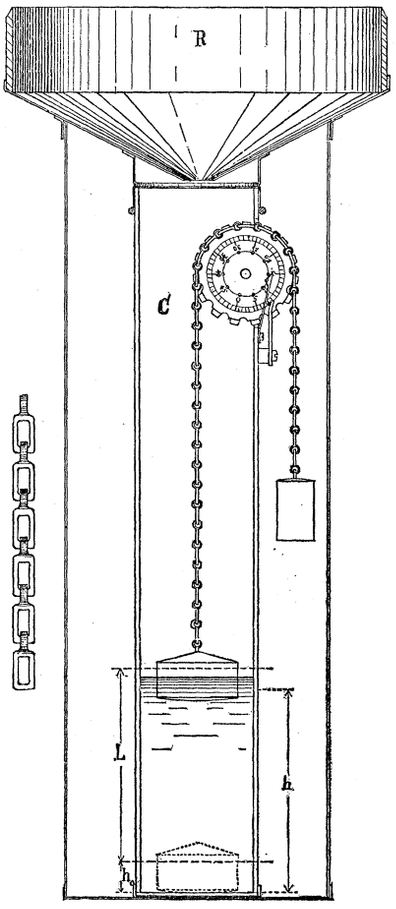
THIS recording mechanism is designed to be attached directly to the Signal Service standard gauge, now in such general use at all regular stations, and also at nearly all volunteer stations.

The figure is a sectional elevation of the gauge with the recording devices in position. The rain is received in the cylindrical part R, and is conducted by means of the funnel-shaped bottom into the inner tube or tall cylinder, which is made of drawn brass tubing, accurately sized, so that its sectional area is just one-tenth that of the receiver R, thus magnifying the rainfall tenfold. R is made eight inches in diameter, and the brass tube is twenty inches high, and holds two inches of rainfall, any in excess of this quantity overflowing into the outer cylinder, where it is retained and subsequently measured.

The recording mechanism needs little explanation. Definite, positive rotation of the dial-wheel in response to movements of the float is secured by use of the sprocket wheel and chain. A few links of the latter in enlarged view are shown on the left. The sprocket-wheel is graduated into divisions, each corresponding to a hundredth of an inch of rainfall. At intervals of every five divisions the wheel is set with small pins, which, when the wheel revolves, successively deflect a feeble spring, and momentarily close an electric circuit, thus recording successive five-hundredths of an inch of rainfall. The record is made in precisely the same manner as that in which the wind-velocity is now recorded at all signal service stations. Wires from the rain-gauge lead to a battery and an electro-magnet which operates an armature provided with a pen or pencil that traces a line on a sheet of paper wound on a cylinder slowly revolved by clock-work. When the electric circuit is closed, the pen is drawn aside, and makes a small notch in the line, each notch representing five-hundredths of an inch of rainfall.

Although the chain is quite light, weighing but a few grams per foot, yet its weight cannot be neglected, modifying, as it does, the conditions of equilibrium between the float and counterpoise. Thus, imagine the gauge to be empty, and the float resting on the bottom. It is evident that a certain quantity of water must be added before the float will begin to be lifted on the water. This condition is indicated in the figure by the dotted lines, and with the height of the water marked h_0. In order to properly include in the measurement this quantity of water, which must be added before the float just begins to be lifted, the graduated disk, which for this purpose is made adjustable on the sprocket-wheel, is set, not with its zero-line to the index-point, but with some other line, — a line corresponding in its value to the quantity of water required to just support the float when at the bottom of the gauge. Allowance is thus made once for all, and the graduated disk, with its pins, firmly and finally attached to the body of the wheel. Now, as more water is added, the float rises. But it is observed, that, as the chain passes over the wheel, its weight is not only added to that on the counterpoise side, but is also subtracted from that on the float side; so that the equilibrium is, on the one hand, disturbed by twice the weight of the chain passing over the wheel, and, on the other hand, is restored by the rise of the float itself in the water. It follows, therefore,

that the float gradually rides higher and higher on the water as more and more chain passes over the wheel. All mechanical arrangements of fusee or other expedient to secure uniform flotation are entirely unnecessary, since the variable flotation in this case follows a well-defined linear law, and is perfectly compensated for by a proper choice of the diameter of the wheel taken in connection with the number of divisions into which it is graduated; that is, we do not make the divisions on the disk to correspond to the amount of chain passing over the wheel, but to the actual rise of water in the tube, regardless of what the former may have been. However, since we wish to record each five-hundredth of an inch of rainfall, the rise of water in the tube necessary to cause the wheel to make



just one revolution must be some multiple of five-tenths of an inch, as the pins in the graduated disk must be equally distant throughout, and five-tenths of an inch of water in the tube correspond to five-hundredths of an inch of rainfall.

Moreover, the outer circumference of the wheel must likewise be some multiple of the length of the links of the chain in order that the teeth may be equally distant. The dimensions of the wheel and other parts to fit any particular chain are therefore chosen under certain limitations, but are easily found as follows: —

Let D = the diameter of the tube C.
" d = " " " " float.
" w = weight of unit length of chain.
" w' = " " " volume of water.
" R = radius of the wheel on its pitch line.
" m = number of pins to be placed in the wheel.
" n = " " teeth in wheel.
" l = length of links of chain from centre to centre.
" h_o = depth of water when float is just supported at bottom.
" h = any depth of water to be measured.
" L = length of chain passing over wheel while the float rises on this water.
" h' = amount the float rises out of the water in coming to this position.

In its upper position the float displaces less water than when just supported at the bottom, the difference being a volume,

$$\frac{\pi d^2}{4} h',$$

and the weight of this volume is equal to twice the weight of chain passing over the wheel in reaching its upper position, or

$$\frac{\pi d^2}{4} w'h' = 2wL, \text{ and } h' = \frac{8wL}{\pi d^2 w'}:$$

hence, while the float has risen a distance L, the surface of the water has risen a distance $L-h'$, and its height from the bottom of the tube is $L-h'+h_o$; but the gauge is so made that the true rainfall is measured not from the surface around the float, but from the surface the water would assume were the float entirely removed.

The volume of water occupying the annular space around the float is

$$\frac{\pi}{4}(D^2-d^2)(h_o-h').$$

When the float is removed, this volume may be considered as spreading itself out in a layer of thickness t, given by the expression

$$\frac{\pi D^2}{4} t = \frac{\pi}{4}(D^2-d^2)(h_o-h').$$

But the former thickness of the annular volume of water was h_o-h'; hence, on removing the float, the surface of the water will fall a distance $(h_o-h')-t$, which will be found to be

$$\frac{d^2}{D^2}(h_o-h').$$

The true amount of rainfall is therefore found, after reduction, to be

$$h = L\left\{1-\frac{8w}{\pi w'}\left[\frac{1}{d^2}-\frac{1}{D^2}\right]\right\}+\frac{D^2-d^2}{D^2}h_o.$$

The last term is the amount of rainfall in true measure that must collect before the float begins to be lifted, and is the number on the graduated disk that must come opposite the index-point when the float touches the bottom of the gauge.

To find the radius of the wheel, we will consider one complete revolution and the rise of water in the tube necessary to produce this amount of motion.

For this we must have

$$0.5m = 2\pi R\left\{1-\frac{8w}{\pi w'}\left[\frac{1}{d^2}-\frac{1}{D^2}\right]\right\},$$

but $2\pi R = nl$

$$\therefore\ m = 2nl\left\{1-\frac{8w}{\pi w'}\left[\frac{1}{d^2}-\frac{1}{D^2}\right]\right\},$$

$$\text{or } m = n\left[a-\frac{b}{d^2}\right],$$

for the quantities are all known but m, n, and d.

This equation may also be written

$$d^2 = \frac{nb}{an-m},$$

and from these the value of R is found as follows: a trial value of d is assumed of approximately its desired final value. With this in the first of the last two equations, a few values of m are computed, using such consecutive values of n (the number of teeth) as would correspond to a wheel of reasonable size. In all probability, none of these values of m will be whole numbers, but some one of them will doubtless be very nearly a whole number. Taking the integral part of this and the corresponding value of n, the final value of d is computed from the last equation. With the same value of n, the radius of the wheel is given by the expression

$$R = \frac{nl}{2\pi},$$

and all the elements of the gauge are completely determined.

C. F. MARVIN.

Washington, D.C., Feb. 13.